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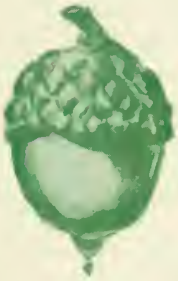
SILVICAL CHARACTERISTICS of

BLACK OAK



Kenneth A. Brinkman

Central States Forest Experiment Station Miscellaneous Release 19
U. S. Department of Agriculture . . . . Forest Service

This is the fifth of a series of 17 papers dealing with the silvical characteristics of forest trees important in the Central States region. The following species are included in this series. (Those marked with an asterisk have already been published.)

*Ohio buckeye
Yellow buckeye
*Northern red oak
*Black oak
Chinkapin oak
Pin oak
White oak
Swamp white oak
Bur oak
Butternut
Black walnut
*Shellbark hickory
Sycamore
Honeylocust
Hackberry
Black locust
*Eastern redcedar

Papers covering additional important American species will be issued by other Forest Experiment Stations of the U. S. Forest Service.

Central States Forest Experiment Station, U. S. Dept. of Agriculture
Forest Service, 111 Old Federal Building, Columbus 15, Ohio
W. G. McGinnies, Director

November 1957

Silvical Characteristics of Black Oak

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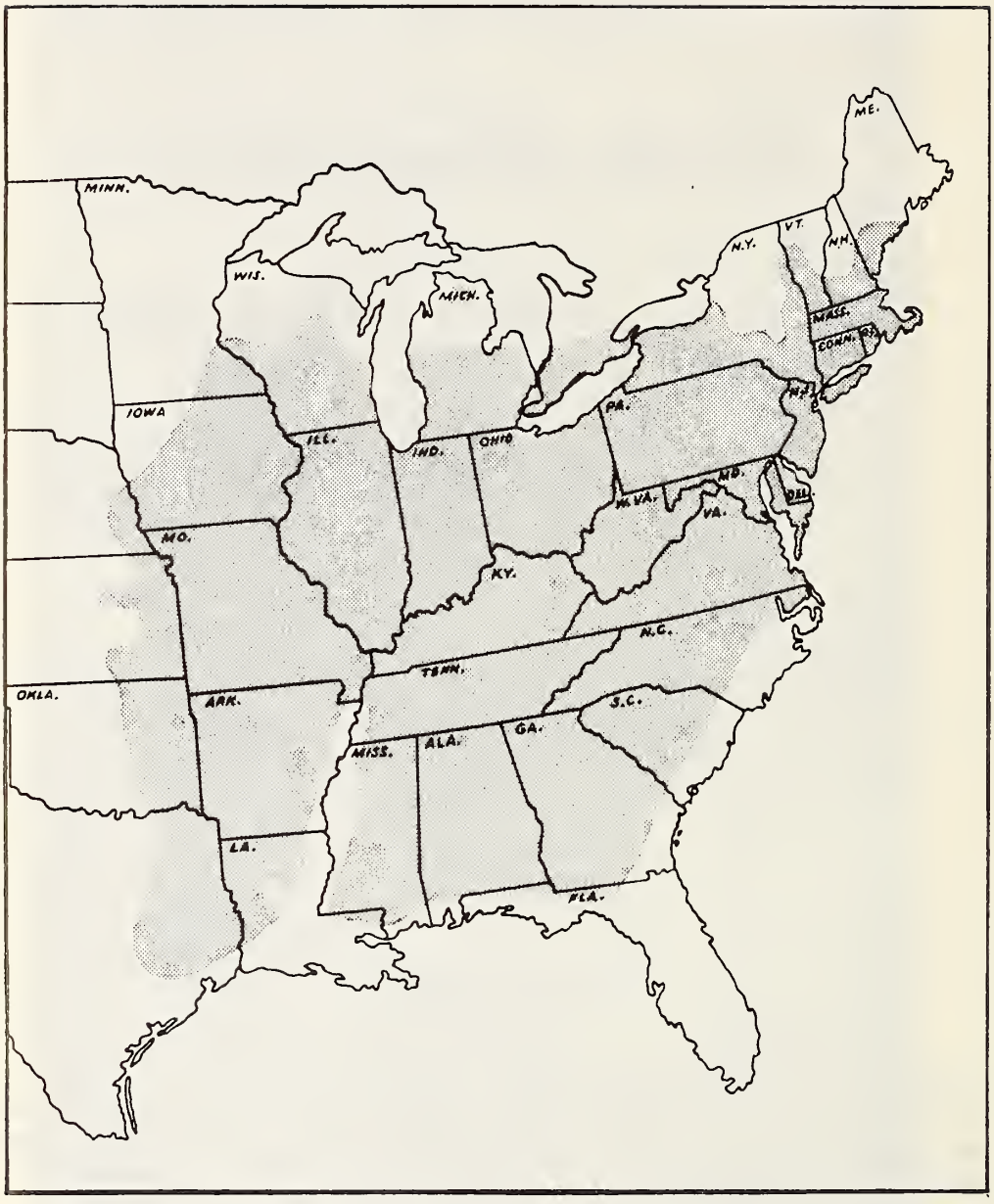
Black oak (Quercus velutina L.) is one of the most common eastern oaks. The species is often rated less valuable than white or northern red oak because it is usually found on poor sites where the trees may be small and too limby to be of great commercial value. High-quality trees, however, often do develop on good sites.

DISTRIBUTION



Black oak is found throughout eastern United States and is widely used wherever trees of merchantable size are found. Its commercial range, however, is centered in Kentucky, Tennessee, Arkansas, and Missouri. Over its wide range, black oak exhibits many modifications in bark, leaves, form, and quality. Hybridization may occur with closely related species.

SITE

Climate

Black oak grows in a wide range of climatic conditions. Mean annual temperature ranges from about 45 degrees Fahrenheit along the northern edge of its range to 68 in east Texas and Florida (31)[1/]. Extreme low temperatures of -45 degrees have occurred where black oak grows. Precipitation also varies greatly, from less than 30 inches per year in Nebraska to 80 inches in parts of the Appalachian Mountains. The frost-free season ranges from 140 days in southeastern Minnesota and Wisconsin to 260 days in east Texas.

Within the optimum range of black oak the climate is more moderate with an annual average temperature of about 55 degrees, precipitation of from 40 to 50 inches, and an average frost-free season of about 180 days.

Soils

The species occurs on a wide variety of soils, but develops best on rich, well-drained soils where it may grow nearly as tall as northern red oak. Black oak is most commonly found on dry, sandy or rocky ridges or upper slopes, or on heavy, glaciated, clay hillsides (15). Young trees characteristically develop long taproots that enable them to survive on dry sites; these taproots may not persist long on the better sites (33). Black oak often is the most numerous species in cutover upland forests.

Physiography

In the southern Appalachian Mountains, black oak is found at elevations approaching 4,000 feet, and often forms an important part of stands in the foothills. The largest trees have been found in the valley of the lower Ohio River (27). Although the species may occur on all aspects, slope positions, and on ridges, near the limits of its range its distribution may be quite restricted. Toward the west, black oak is often found only on north or east aspects where moisture conditions are most favorable. In southern Minnesota and Wisconsin, it is restricted to ridgetops and the lower two-thirds of the south- and west-facing slopes (14).

1/ Numbers in parentheses refer to Literature Cited, p. 11.

Black oak requires less moisture than white and northern red oak, and more than post and blackjack oak. In Indiana, McQueeney (24) found black oak with white oak on upper south slopes, and with beech, sugar maple, and hickory on the lower south slopes. On west aspects, beech and white and black oaks dominated the upper slopes. In the Ozarks, black oak generally is found on upper slopes and ridges where it tends to replace shortleaf pine on heavily cut areas (1).

Associated Species

Black oak is associated with a great many other species throughout its wide range. It occurs commonly in mixture with the hickories; with post, scarlet, southern red, blackjack, and chestnut oaks; and with white and northern red oaks; or in pure stands. In the South it is found with shortleaf pine and occasionally in the second-bottoms where it occupies the highest and best drained areas with loblolly pine, southern red oak, and sweetgum (15). In the forest type classification of the Society of American Foresters, black oak is a chief species in the post oak-black oak, and the white oak-red oak-hickory forest cover types of the central forest region and is represented in 16 other types: 10 in the central, 1 in the northern, and 5 in the southern region (29).

The bitter acorns are a source of food for many animals, especially squirrels, mice, and chipmunks. Deer, rabbits, ruffed grouse, and wood ducks also may feed on the acorns at times (8, 23, 32, 33, 34). In open-range areas, hogs often depend on the mast of oaks for much of their winterfeed. Consumption of seed by mice may be greater under heavy litter than on burned areas. Losses to animals and birds and destruction by insects thus may limit or prevent natural regeneration, particularly during years of scanty acorn production (19).

Seeding Habits

In April or May, when the new leaves are half grown, the staminate flowers appear on the growth of the preceding season. The pistillate flowers are borne at the bases of the current leaf-stems (20, 27). Both types of flowers are present on the same tree, so self-fertilization may occur, as well as cross-fertilization between trees of the same species. Hybridization with others of the red oak group is probably common.

The acorns ripen during September or October of the second year and generally drop before December (30). Good crops of acorns may occur every 2 or 3 years. Black oak is a fairly consistent seed producer; in Missouri the average number of mature acorns per tree generally was higher than for other oak species over a 5-year period (8). The number varies greatly from year to year and from tree to tree even within the same stand (11). Peak seed years apparently do not coincide with those of white oak.

Seed production may start when trees are only 20 years old, reaching optimum at 40 to 75 years (30). The heavy seeds seldom scatter far from their source unless carried by squirrels or other animals or birds.

Vegetative Reproduction

Most existing stands of black oak throughout the Midwest are of sprout origin. The stumps of small trees sprout freely after cutting or after the tops are killed back to the ground by fire. Although the trees that arise from the stumps of large trees may develop heart rot or other decay from the parent stump, there is little evidence that trees originating as sprouts from small stumps or stools have more decay than seedlings. Liming and Johnston (21) found that more than two-thirds of the black oak reproduction in the Missouri Ozarks was of sprout origin. The initial advantage in height growth of sprouts over seedlings of the same age makes it rather difficult for the latter to maintain themselves in a cutover stand.

Seedling Development

Sound acorns of black oak generally show good germination, often as high as 90 percent, but the amount of sound seed may be quite low because of destruction by insects and wildlife. Insects

may damage as much as two-thirds of the crop, particularly in years of poor production (18). In the Appalachians, Downs and McQuilkin (11) reported 30 percent of the mature acorns attacked by insects. Korstian (19) found that black oak acorns were more infested by nut weevils (Curculio spp.), than those of the other oaks.

The sound seed that is not destroyed by insects or animals apparently has a good chance to develop if: (1) It reaches mineral soil or a spot where leaf litter is thin (25), (2) it is lightly covered with new leaves during the winter and is protected from further animal and insect attacks, and (3) the new seedling has adequate light, moisture, and growing space. Vigorous development of the primary root generally follows germination; if this root is able to penetrate the soil an inch or so, the seedling can withstand much dryness in early life (19).

Because of relatively low shade tolerance, black oak seedlings cannot persist long under a dense overstory. This need for light may be responsible for the absence of black oak on the better sites where it cannot compete with faster growing species such as yellow-poplar, red oak, and basswood.

Height growth of black oak begins quite early in the spring, about the time the leaves appear. In Missouri, 90 percent of all height growth of reproduction took place within 11 days, and total annual height growth was essentially complete in 20 days or less (17). Annual height growth thus is quite independent of current summer rainfall.

In contrast, diameter growth begins about April, reaches a peak in June, and tapers off through July with very little additional growth after August. Unfavorable summer rainfall distribution is reflected in slower diameter growth. Moreover, serious deviations in the moisture supply for one year may affect both height and diameter growth the following spring (17).

Sapling Stage to Maturity

Under ideal conditions, black oak may reach 150 feet in height and 4 feet in diameter, but most mature trees are from 60 to 80 feet tall and 2 to 3 feet in diameter. Black oak is a relatively short-lived tree, becoming physiologically mature at 100 years, with some individuals living 150 to 200 years. The growth rate on favorable sites is better than that of white and chestnut oak but not quite as good as that of red oak.

Available yield data are for mixed stands of oaks, since pure stands of black oak are uncommon. Individual trees may contain as much as 800 board-feet of volume, but the more typical tree seldom exceeds 500 board-feet even on good sites. Throughout much of its range, black oak volumes often average 250 board-feet or less per tree at maturity.

Depending on age and site, fully stocked mixed stands in which black oak is an important component may contain from 2,000 to 12,000 board-feet per acre. Growth rates of managed stands will vary from 150 to 350 or more board-feet per acre per year, with a rotation age of 90 to 100 years for sawlog production. Yield and growth vary a great deal with site quality and composition. According to Schnur (28), fully stocked stands at age 100 may contain 7,750 board-feet (Scribner Scale) per acre on site index 50, and nearly 20,000 board-feet per acre on site index 70. On the poor sites where black oak may be expected to be most abundant, volumes may be as low as 3,350 board-feet per acre at maturity.

Reaction to Competition

Black oak is considered to be intermediate in shade tolerance (2). Seedlings usually die soon after being overtopped, but sprouts may persist somewhat longer. By comparison, black oak is more tolerant than yellow-poplar and less so than white oak, hickory, elm, and blackgum. Because of its intolerance, black oak seldom persists in a mixed stand unless it is in the upper crown classes.

Natural pruning is relatively good in heavily stocked stands where the lower branches are shaded out before they grow much larger than 1 to 1 1/2 inches in diameter. On trees in understocked stands, large branches may persist for many years after they die. Artificial pruning of selected young trees may be profitable on good sites (9). An element of risk is involved in such pruning, however, since it frequently stimulates the development of dormant buds.

Partial cuttings in well-stocked stands often cause a heavy development of epicormic branches on trees that are given complete release. This is not quite such a problem with dominant trees (6).

Climax Position

Together with the other oaks and hickory, black oak is considered to be part of the climax association in the central and southern upland hardwoods (3). Unlike a true climax species, however, it usually cannot succeed itself unless some major disturbance occurs in the forest canopy. Black oak generally persists on poor sites in Michigan, displacing the other oaks (14). Trees up to pole-timber size are easily killed back to the ground by fire and trees of all ages and sizes are damaged severely by ground fires. Although such fires seldom kill the larger trees, they cause fire scars that admit insects and disease. Black oak may be succeeded by sugar maple and beech in the northern part of its range, particularly on good sites. White oak and hickory often outlast it in mixed stands to become the climax forest. On poor sites, black oak may be replaced by post or blackjack oaks in the west, and by chestnut and scarlet oaks in the east and south.

ENEMIES AND HAZARDS

Insects

When they become epidemic, insects may kill or damage trees, but ordinarily they seldom do more than disfigure twigs or bark unless the trees have been weakened by drouth or suppression, or damaged by fire or wind. Insects probably are most important as potential carriers of diseases such as oak wilt. Wood borers as a class are important from the economic viewpoint because of the damage they cause to the heartwood of the living tree or to freshly cut logs (10).

Diseases

The chief cause of defect in black oak is the decay associated with fire scars and branch stubs, although insect damage also may be severe. The cull due to heart rot generally increases with time, proceeding relatively slowly up the trunk of the tree (7, 13, 16). Large dead branches may persist many years, leaving large pockets of infection as they rot off. These openings are often so located as to catch rainfall and stem runoff, which aid in maintaining and spreading the decay. The amount of decay depends upon the size of wounds or opening, the fungi involved, and the time since wounding (16). In parts of the Missouri Ozarks, 1 tree in every 3 is cull because of decay and insect damage associated with fire scars, branch stubs, and other wounds.

Oak wilt, caused by the fungus Ceratocystis fagacearum (Bretz) Hunt., has the greatest potential as a destructive disease of black oak (4, 5). The disease already is widespread throughout the central states and in some eastern states, but fortunately is not epidemic except in very localized areas. Black oaks die within a few weeks after the symptoms first become evident. More information is needed, particularly on overland spread of the fungus, before adequate control measures can be devised.

RACES AND HYBRIDS

Throughout its wide range, black oak hybridizes with others of the red and black oak group. Controlled pollination of the oaks is very difficult, partly because fruitfulness is so uncertain (35). At least 10 natural hybrids have been recognized (12, 22, 26). These include:

Quercus x bushii Sarg. (Q. marilandica x velutina)
Q. x demarei Ashe (Q. nigra x velutina)
Q. x filialis Little (Q. phellos x velutina)
Q. x hawkinsiae Sudw. (Q. rubra x velutina)
Q. x leana Nutt. (Q. imbricaria x velutina)
Q. x palaeolithicola Trel. (Q. ellipsoidalis x velutina)
Q. x podophylla Trel. (Q. incana x velutina)
Q. x rehderi Trel. (Q. ilicifolia x velutina)
Q. x vaga Palmer & Steyerm. (Q. palustris x velutina)
Q. x willdenowiana (Dippel) Zabel (Q. falcata x velutina)

Although definite races of black oak have not been identified, they undoubtedly exist in a species with such a wide range. Individual trees vary greatly in external characteristics; even within a single stand atypical specimens of the species may be found that are difficult to reconcile with the usual species descriptions. Clearcut races possibly are masked by the tendency toward hybridization.

TREE SPECIES MENTIONED

Beech	-	*Fagus* L.
Blackgum	-	*Nyssa sylvatica* Marsh.
Elm	-	*Ulmus* L.
Hickory	-	*Carya* Nutt.
Sugar maple	-	*Acer saccharum* Marsh.
Black oak	-	*Quercus velutina* Lam.
Blackjack oak	-	*Q. marilandica* Muenchh.
Chestnut oak	-	*Q. prinus* L.
Northern red oak	-	*Q. rubra* L.
Post oak	-	*Q. stellata* Wangenh.
Scarlet oak	-	*Q. coccinea* Muenchh.
Southern red oak	-	*Q. falcata* Michx.
White oak	-	*Q. alba* L.
Loblolly pine	-	*Pinus taeda* L.
Shortleaf pine	-	*P. echinata* Mill.
Sweetgum	-	*Liquidambar styraciflua* L.
Yellow-poplar	-	*Liriodendron tulipifera* L.

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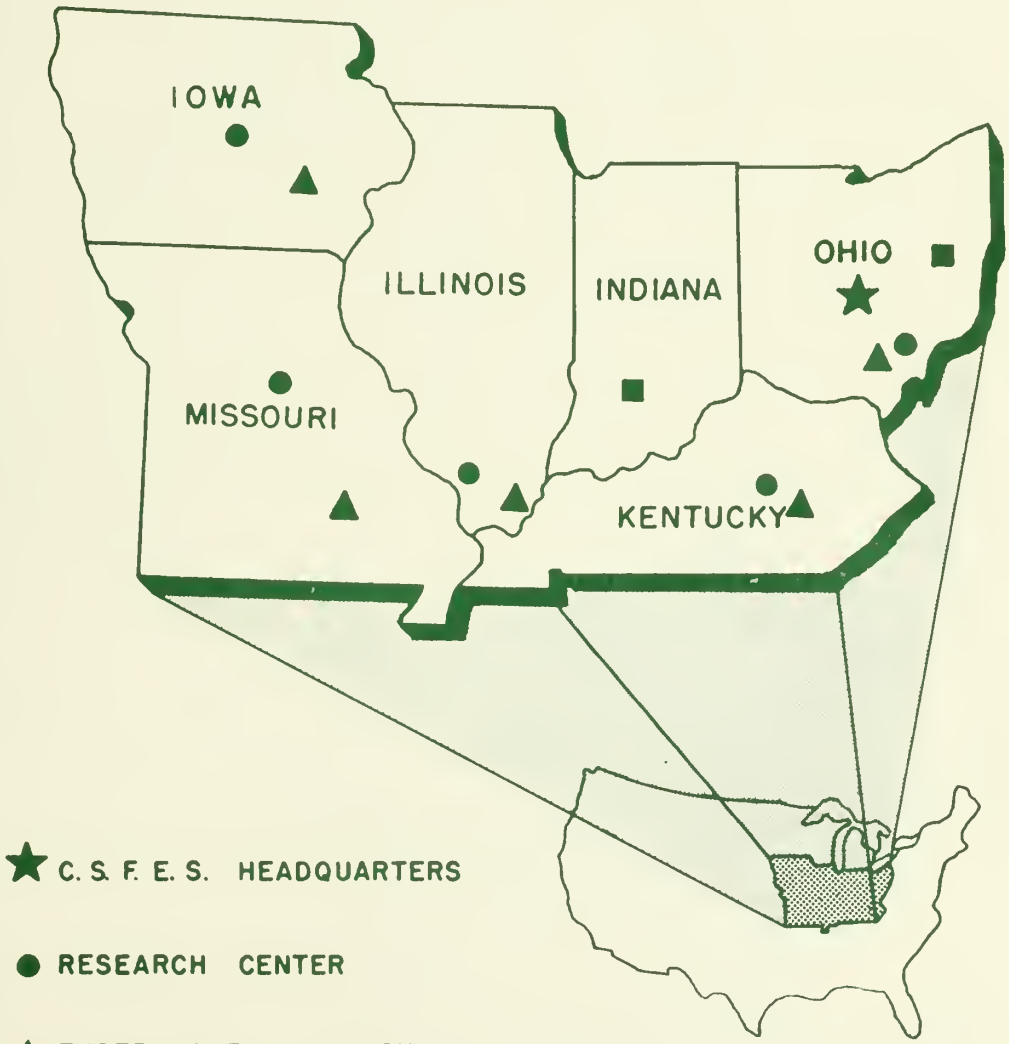
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